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EFFECT OF VARIOUS CHARACTERISTICS OF RAW WOOD ON ENERGY SATURATION OF THE CHIPPER

Grinding of raw wood into chips is a complex process depending on various factors. Study of a grinding process is complicated not only because of a large number of these factors, but also because of the possibility of many combinations. Cutting power can be considered to be one of the criterion determining the extent and nature of these factors influence on the grinding process.

Introduction. Main source of wood raw material in Belarus is aboriginal forest resources. Total amount of growing forest in the country comprises 1495 mln. m³, average stock of mature stands per 1 hectare is 248 m³. Dominating species are pine (50.2%); birch (22.6%); spruce (9.8%). Lands of forest resources (9.39 mln hectares) occupy 44% of country. Percentage of forest land comprises 38.1% [1]. At present forest exploitation of 1 hectare comprises with forest 1.5–1.7 m³. Comparing value of basic increment (32 million m³ per year) and its utilisation (41%), it is possible to note, that intensity of forest exploitation is low. Incomplete use of wood potential today results from lack of possibility of using small merchantable wood being out of demand on the market. Wholesale consumers of fuel and energy resource – basically producers energy (heat and the electric power) of small and average power can become such a market [1]. So, there have been built 16 sources of energy (mini-HES), working on wood and other types of domestic fuel: in “Bellesbumprom” – 3, Minzhilkomhoz – 3 and Ministry of Power Generating Industry – 10 with annual demand of 1.2 million m³ of wood fuel.

To provide successful operation of these mini-HES it is necessary to have chippers w which help to produce wood fuel. Such machinery is the most

energy-intensive, complex and expansive mechanisms in the process chips production. Therefore one of the major aspects for designing of chippers is the competent justification of energetic unit power.

Main part. A portable chipper is a complex structure interconnected components and mechanisms (Fig. 1). All of them, as a rule, are powered by independent motor through mechanic (a knife drum, a fan, a spiral conveyor) and hydraulic (feeding mechanism (a feed conveyor, rollers)) gears.

The lumber grinding is a labor-consuming process. Therefore, first of all it is necessary to pay attention to the dimensional and physical characteristics of raw being ground. Over-all performance, quality of chipwood, production price and eventually production profitability depends on adequate justification of chipper energy parameters.

According to the calculation technique of Denfer [2, 3] values of cutting powers have been rated by changing various parameters such as geometrical parameters of a charging hole (b), quotient of resistivity to cutting (K) (Fig. 2), diameter lumber being ground (d) (Fig. 3). The data obtained have given the chance to draw plots which visually allow to estimate power fluctuations with an increase of cutting strength and to select a rational power range.

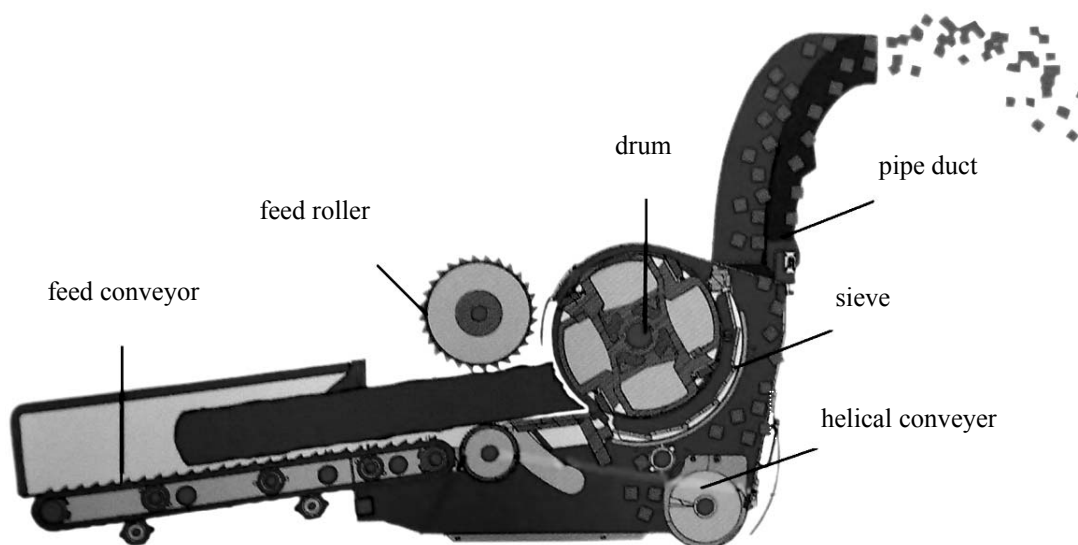


Fig. 1. The scheme of chipping unit

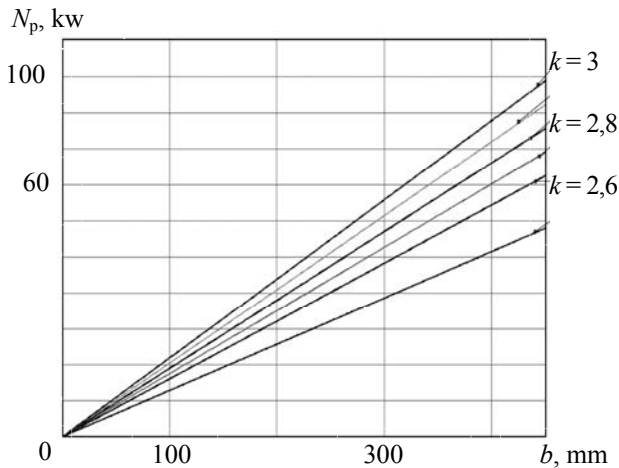


Fig. 2. Plots of cutting power fluctuation and width of charging hole at various quotient of a resistivity to cutting

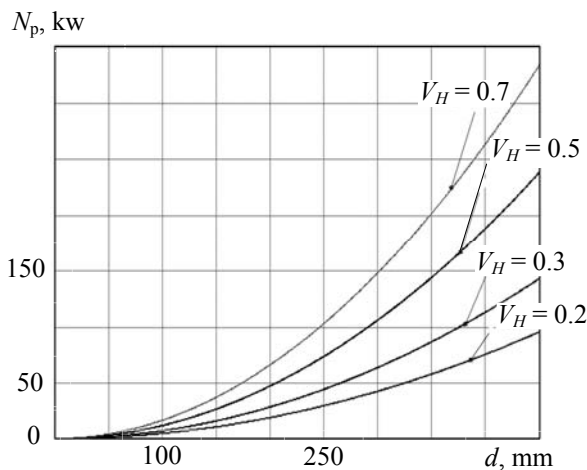


Fig. 3. Plots of power fluctuations of cutting power and diameter fluctuations of lumber being ground at various feed rates

Having analyzed the obtained plots, it is possible to determine, that with a of quotient of an increase of resistivity to cutting from 2 till 3, cutting power increases to 100 kw. Ultimate power is observed at worst conditions of wood grinding namely when the quotient of a resistivity to cutting is maximum (charging hole width is 45 cm) which considers effect of species, moisture in wood and a degree of cutting tool pointing. Such cutting mode at a long-term grinding of wood is irrational because of fuel diseconomy. The quotient of a resistivity to cutting can be reduced to 2, owing to dry resharpener of a cutting tool and using air-dried wood. Besides, with an increase of a quotient of charging hole filling and its widths rise wood cutting power till 75 kw is observed.

To grinding in a drum chipper we can subject not only twigs and slabs, but also poor-quality stemwood. Thereupon correlative plots of cutting power fluctuation and diameter of ground workable timber have been obtained.

At the diameter being ground is more than 40 cm power increase is high enough, thus the best value of power is observed when grinding workable timber in diameter 20–30 cm. Significant increase of power also takes place with a rise of a feed rate of workable timber. Based on previous plots the rational feed rate is in the range of 0.45–0.25 m/s.

The obtained plots allow to draw a conclusion that planning the power of a chopper it is necessary to consider variables as they are directly influence on efficiency.

For the removal of a chopper transporter pull it is necessary to apply the tractive force indispensable for overcoming resistances which prevent this motion. At steady motion in transport installations there are two kinds of tractive resistance: resistance to support friction and resistance to lifting. The first of them depends on the kind of support and a coefficient of friction. The second is in dependence from fluctuations of a lifting height of load and parts of a pull.

Fig. 4 represents the basic design model of transporter with both branches, top and bottom of the pull are supported by bearing parts, the pull wheel is on the right, load is on the top and it moves towards pull wheel. Route being passed by a pull, consists of four stretches, two of them are straight-line: 1–2 and 3–4 and another two are curvilinear: 2–3 and 4–1.

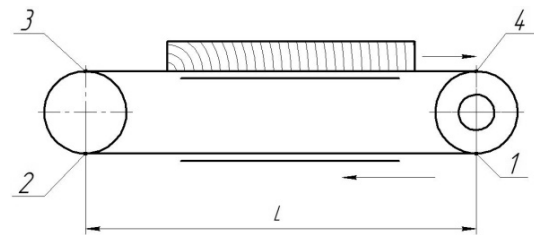


Fig. 4. The design model of transporter

Based on design model of outline calculating, values of power drive of a feed conveyor (Fig. 5) have been received.

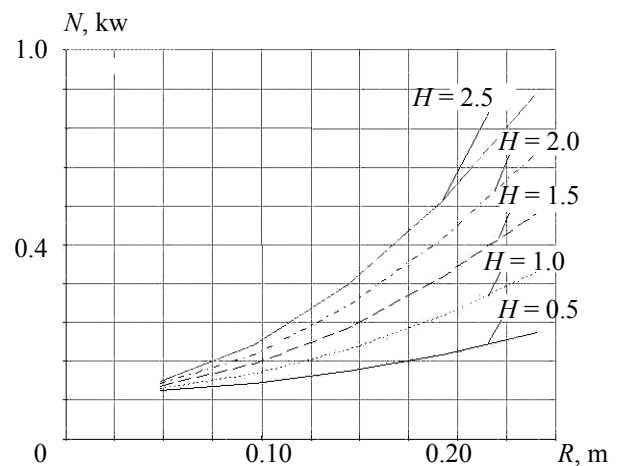


Fig. 5. Plots of drive power fluctuations of feed conveyor and radius fluctuations (R) and lengths (H) of workable timber being ground

Plots analysis of the power consumed by a feed conveyor, at various diameter (radius R) and a length (H) of workable timber showed, that a rise in variable parameters tends to increase a drive power of a feed conveyor. So, the ultimate capacity consumed on transfer of workable timber in diameter of 0.5 m and length of 2.5 m does not exceed 1 kw.

Modern highly-productive chippers are equipped by rolling mechanisms for feeding wood raw material.

Fig. 6 shows plots of power consumed by feeding rolls with various diameter (radius R) and length (H) of workable timber. At fluctuation of diameter of workable timber from 0.1 to 0.5 m an increase of power for these plots fluctuates in a range from 0.8 till 2.5 kw.

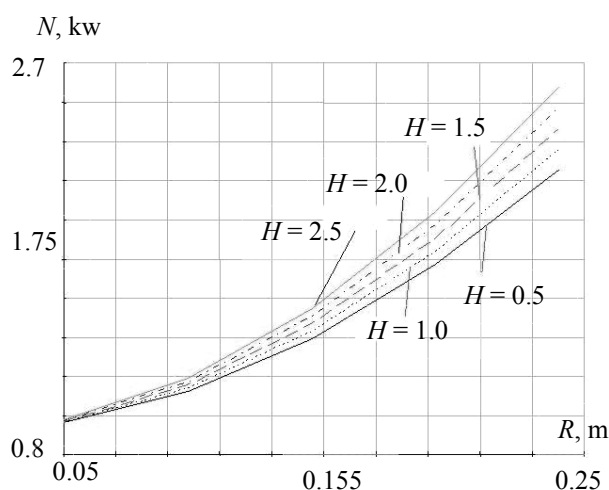


Fig. 6. Plots of drive power fluctuation in feeding rolls and radius fluctuation (R) and lengths (H) of workable timber

In chippers spiral conveyors are applied to reduce wood transportation to a fan which makes the upper blowout of chipwood. In spiral conveyors the cargo movement is implemented by means of propeller which gives reciprocating motion to cargo.

Depending on physical condition of ground wood power on a spiral conveyor drive gear varies (Fig. 7).

So, at air seasoning of wood power is reduced from 1, 3 to 0.7 kw. Analysis of dependencies of fluctuation of a drive power of a spiral conveyor from species of lumber shows, that the most energy-intensive transportation is for such species as birch, because of its larger tightness in comparison to other considered species. So, for example, for a freshly-cut birch power comprises 1.25 kw, and for pine – 1 kw.

In chippers there are two modes of removing chipwood from housing: 1) by means of the blades installed on a rim of a knife drum, the chipwood pursues on the pipe duct in the cy-

clone separator or the storage bin); 2) under the influence of a component force of cutting and a gravity chipwood drops on the transporter disposed from below the storage bin, thus there are on blades on a drum head rim. The first mode is more wide-spread because of possibility of transportation of a chipwood without the use of additional mechanisms.

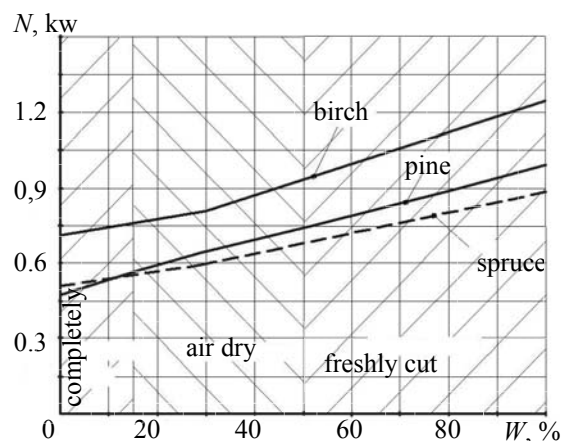


Fig. 7. Plots of drive power fluctuation of spiral conveyor of the chipping unit and humidity fluctuation (W) and species of workable timber being ground

At mechanical removal of a chipwood from a chopper housing in the storage bin-store energy is consumed on lifting raw material from a housing heel to its top and on kinetic energy generating at particles flow from fan blades.

When grinding green wood there is an increase in drive power of the fan almost in 2 times in comparison with dry one (Fig. 8). The peak power value is reached at ejecting of a freshly-cut birch and it comprises 41 kW.

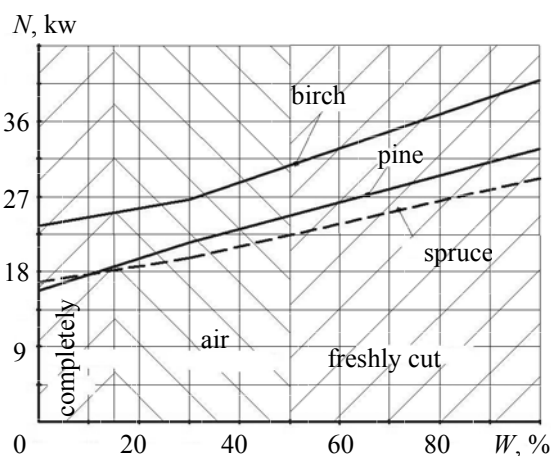


Fig. 8. Plots of drive power fluctuation in the fan of chipping unit and humidity fluctuation (W) and species of the ground workable timber

Having analyzed the obtained relations, it is possible to mark, that the power consumed on a drive gear of the fan of the chipping unit is great enough. Therefore, we can suppose, that in chipper having upper blowouts mechanic ejection of chip wood by blower blades take place. Turning fan blades catch chip wood from the lower part of coat grinder and throw it out to chip conductor installed upright the coat at some angle. Movement of chip particle in pipe occurs in narrow conditions and accompanied by their ratcheting.

Power of independent motor will be consumed not only for basic operations of a chipper e. d. grinding, feeding of raw material by means of the transporter and rollers, chipwood transfer to the fan and chipwood blowout, but also for nonproductive operations.

Conclusion. Factors defining the process of cutting lumber, can be referred to lumber being cut, to cutting tools and mechanisms. Analysis cutting lumber becomes complicated not only because a number of factors, but also in connection with a capability of their multiple combinations. These factors create various conditions of chip formation. To determine a degree and nature of these factors effect on a lumber cutting

process, there is a need in common criterion for them. Usually such criterion is a value of cutting power subject to the quality of machining and value of efficiency. Species of wood and its physical-mechanical properties make a significant influence on the process chip formation, cutting force and energy consumption. The cutting rate works upon cleanness of a cut and quality of chipwood. An increase of cutting speed results in a rise of cut cleanness.

Having analyzed the obtained data, it is possible to draw a conclusion, that the most energy-intensive process is namely grinding of wood raw material and its blowout by means of the fan.

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